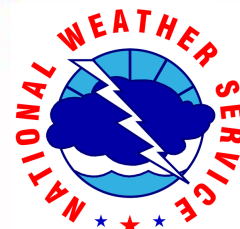


# SkyScoop

The Newsletter of the National Weather Service in Wilmington, Ohio

National Oceanic and Atmospheric Administration (NOAA) – US Department of Commerce (DOC)



ISSUE 19

FALL/WINTER 2011

## It Takes Teamwork

Michael Kurz

While most meteorologists would unashamedly acknowledge their fascination with thunderstorms and tornadoes, they would probably also admit that working a severe weather event can be challenging and stressful at times. And while it doesn't happen often, when an important piece of equipment happens to fail during a severe weather event, things can quickly become very tense—especially if that piece of equipment happens to be the radar. The situation can present meteorologists in the warning seat with additional challenges that require them to rely on other resources and use all of their training to provide the best service possible.

A warm and humid air mass was in place over the Ohio Valley on the evening of June 27, 2011. With weak to moderate instability, decent wind shear, and a warm front moving into the region, meteorologists at the National Weather Service in Wilmington were aware of the possibility for severe weather that evening. Not long after some thunderstorms began to pop up on radar, a red banner suddenly appeared on each computer workstation, announcing “KILN radar data unavailable.” Although this is never a welcome message, sometimes all it takes to clear a glitch like this is to reboot the radar system. However, after a couple unsuccessful attempts, it quickly became apparent to the meteorologists on duty that they were facing a problem that would require additional support. Meanwhile, the storms continued to intensify.

While most people know that National Weather Service forecast offices are staffed by several meteorologists, not everyone is aware that each office also has a team of electronics technicians (ETs, as they are commonly called) on hand to handle equipment or facilities-related problems. Since it was evening, all of



NWS upper air inflation shelter with a large funnel cloud developing in the distance. Photo courtesy of Michael Kurz (NWS employee).

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the office's ETs had already gone home for the day, but with a couple of phone calls, two of them agreed to quickly come back to the office to assess the situation. After some diagnostics, they soon determined the problem with the radar and took action to fix it. With the Wilmington WSR-88D (Weather Surveillance Radar, 1988, Doppler—the technical name for the radar) inoperative, meteorologists had to rely on radar data from neighboring NWS offices as well as Terminal Doppler Weather Radar (TDWR) from Cincinnati, Dayton, and Columbus to help fill the radar data gap. Storm spotters also played a vital role in the warning process that evening by providing the NWS with ground truth information that meteorologists could not glean from radar data alone.

A little before 8 pm, some decent rotation developed in a storm over Brown County, Ohio. After quickly assessing the situation and the limitations at hand, one of the meteorologists decided to issue a tornado warning.

(Continued on page 8)

## A Letter from the Warning Coordination Meteorologist

Dear Skywarn Spotter,

Skywarn spotters, providing reliable real-time severe weather reports, are a vital part of the warning process. So far this year, the National Weather Service in Wilmington, Ohio has conducted 44 training sessions (including one advanced spotter session) for approximately 1,800 spotters. We will be starting the majority of our spotter training sessions for 2012 soon after January 1st. Each volunteer spotter should attend a training session every two to three years. Our program changes from year to year, and there is always something new to learn. Be sure to check our website in the coming months for the latest listing of classes; it will be updated as new classes are scheduled. If you have any questions, please contact our office.

I would also like to extend a thank you to all the Skywarn spotters that have supported our warning program in the past. This includes emergency service personnel, private citizens, and the amateur radio community. Amateur radio operators can play a critical role in the Skywarn program, and their efforts are greatly appreciated. Special thanks go out to those amateur radio operators that function as section net control operators and the local amateur radio operators that work with us here at the NWS Wilmington office. They activate upon our request, no matter what time of day or night.

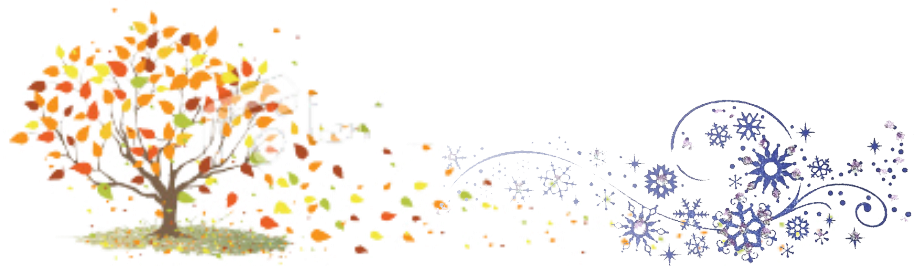
We hope you find the articles in this newsletter to be interesting and informative. This has been a very active year for severe weather and flooding, and we have seen more than the average number of tornadoes. Included are articles about the June 27th funnel cloud/tornado event, record-breaking spring rainfall, widespread overnight severe weather in April, and a stretch of significant severe weather in late May. We also included an article that details why, when, and how we conduct damage surveys. Looking ahead to winter, we discuss the 2011-2012 winter outlook and extend an invitation for you to become an online snow spotter. These are just some of the highlights of this latest issue of SkyScoop.

We would love to receive any ideas you might have for future newsletters. You can send your ideas to us via email at [spotreport.iln@noaa.gov](mailto:spotreport.iln@noaa.gov). If you don't have internet access, please send them to us via postal mail in care of the Warning Coordination Meteorologist. We extend a special welcome to any new Skywarn spotters and also thank those who continue to work with us as members of the Wilmington Skywarn network. I'd also like to invite you to visit our office's new Facebook page! We look forward to seeing you at our training classes.

Regards,



Mary Jo Parker  
Warning Coordination Meteorologist  
National Weather Service Wilmington, OH  
1901 S. State Route 134  
Wilmington, OH 45177



## Have an Exciting Weather Photo? We Want to See It!

The National Weather Service in Wilmington wants to make it possible for weather spotters across the tri-state to showcase their photos to the world! Pictures may be used in future editions of this newsletter, for spotter training, and/or in the photo gallery on our website. To participate, send your photos or any other questions to [spotreport.iln@noaa.gov](mailto:spotreport.iln@noaa.gov). Remember to express your permission for your credited work to be displayed on our website, in this publication, or in a spotter training presentation.



*Please be careful! Lightning, flooding, tornadoes, and ice storms make for great photography — but great danger as well. The staff of the National Weather Service urges everyone to respect the weather and take photographs only when it is safe to do so.*

## Are You Prepared for Winter?

*A disaster supply kit should include the following items:*

- ◆ 3-day supply of water (one gallon per person, per day)
- ◆ Non-perishable foods
- ◆ One change of clothing and shoes per person
- ◆ Portable radio and flashlight with extra batteries
- ◆ Extra set of car keys
- ◆ Cash/credit card
- ◆ Special items for infant, elderly, or disabled family members
- ◆ One blanket or sleeping bag per person
- ◆ First-aid kit and prescription medications
- ◆ Emergency tools
- ◆ Battery-powered NOAA Weather Radio

*For more winter weather information and safety tips, visit:*

**<http://www.weather.gov/om/winterstorm/winterstorms.pdf>**

## Become Part of Our Online Snow Spotter Program!

**Jim Lott**

The National Weather Service in Wilmington will once again be utilizing an online system for receiving snowfall reports during the 2011-2012 winter season. This is a continuation of an experimental program that we initiated last winter. The experiment was very successful and helped us increase our real-time snowfall reports. Since there is often great variability in snowfall over short distances, these real-time reports give meteorologists at the National Weather Service a better understanding of how much snow has actually fallen across the area, ultimately helping them create more accurate forecasts.

We are looking for even more volunteers to participate in our online snow spotter program this winter. All you need in order to help us is a ruler, access to the internet, and a willingness to brave the winter elements. Once you take a snow measurement, you can send it to us through the eSpotter website. As we receive reports, we will QC them and disseminate them via our local storm report product. Your snow reports will also be included on our website and in snow summaries sent out periodically from our office. Reports received via phone will still be welcomed, but if you have internet access and a little time, please consider becoming a part of this online network. More information on how to become a snow spotter can be found on our website at <http://www.erh.noaa.gov/iln/spotter/online-snowspotter.php>.

## Record-Breaking Spring Leads to Federal Disaster Declaration

**Julie Dian-Reed**

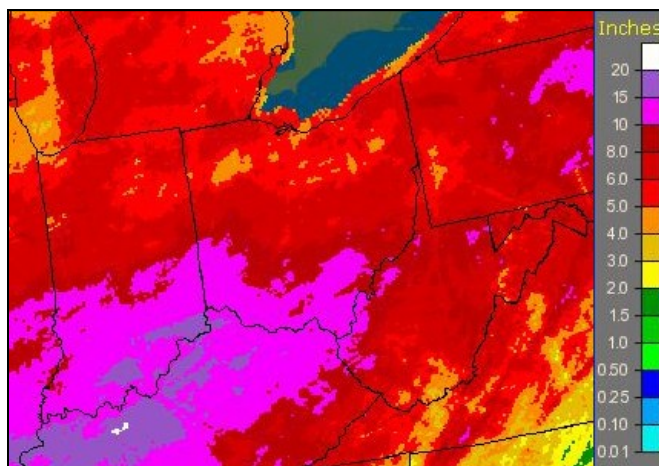
Record-breaking rainfall impacted the Ohio Valley this past spring. In fact, in April the official observing station in Cincinnati (at the Cincinnati/Northern KY International Airport) was just 0.16 inches shy of setting a record for the wettest month ever! The extreme April 2011 rainfall of 13.52 inches fell just short of the old January 1937 precipitation record of 13.68 inches. For you history buffs, that record precipitation led to the all-time highest Ohio River flood stage at Cincinnati, when the river crested at 80 feet on January 26th, 1937.

April 2011 broke records at Cincinnati and Columbus for being the wettest April ever recorded at those locations. Columbus recorded 7.14 inches, beating the longstanding 1893 record of 7.08 inches. All the rainfall at Cincinnati smashed the previous April precipitation record of 9.77 inches set in 1998. Dayton's rainfall of 8.72 inches was second only to the 9.20 inches recorded in 1996.

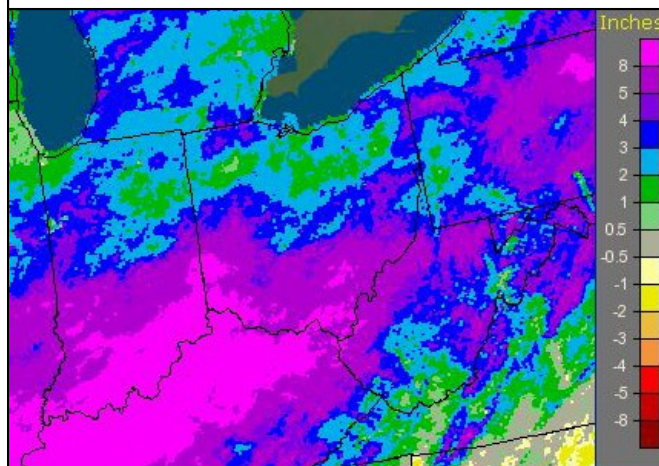
These record April precipitation values made a significant contribution towards making this past spring (meteorological spring is March through May) one of the wettest in climate history across the area. With 24.78 inches of precipitation, this was Cincinnati's wettest spring on record (previously it was 22.98 inches in 1996). Dayton and Columbus both experienced their third wettest spring on record.

As a result of all the rain, the Ohio River exceeded flood stage not once, but twice within the NWS Wilmington service area (from Portsmouth to Markland) for the first time since 2005. Numerous tributaries to the Ohio River flooded on each occasion, but no single storm or even two-day storm was to blame. A prolonged period of widespread, heavy rain is required for the Ohio River to reach flood stage (as opposed to a localized heavy rain occurrence), and this was certainly the case this past spring. The February 28th heavy rain/snowmelt flood (see SWE article) was the start of an active, wet pattern across the Ohio Valley.

*(Continued on page 7)*



**April 2011 observed precipitation across the Ohio Valley. The Cincinnati area saw record rainfall amounts between 10 to 15 inches.**  
Image courtesy of NOAA/NWS.



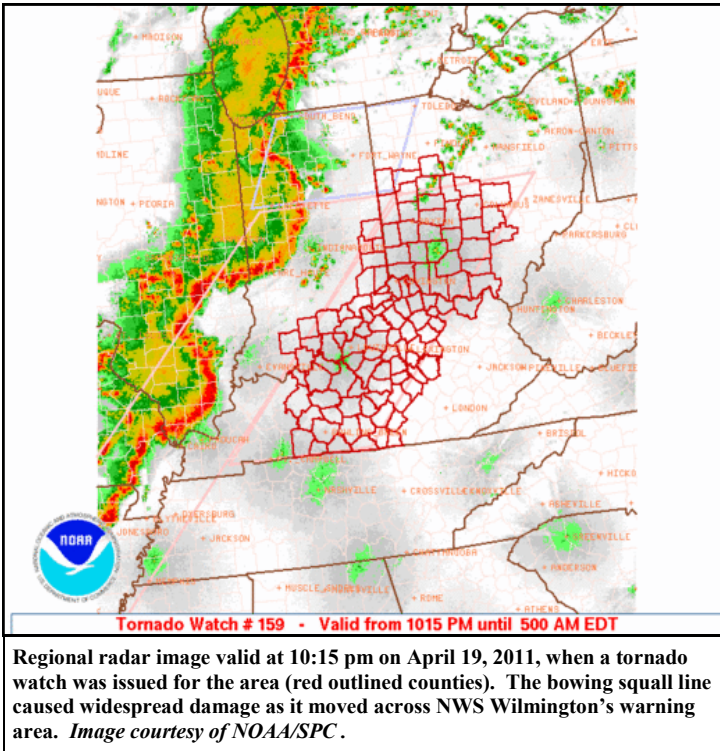
**April 2011 departure from normal precipitation across the Ohio Valley. The Cincinnati area was close to ten inches above normal!**  
Image courtesy of NOAA/NWS.

# Widespread Severe Weather Strikes Overnight

Andrew Snyder

Many people may remember being woken up or kept up late by powerful thunderstorms that moved through the area on the night of April 19-20, 2011. The National Weather Service in Wilmington issued a combined forty severe thunderstorm, tornado, and flash flood warnings during the overnight hours alone, which blanketed nearly the entire county warning area.

A round of storms had already moved through during the morning hours of April 19th, causing some minor flooding. An area of low pressure deepened rapidly during the evening hours as it tracked from central Illinois toward Lake Erie. The atmosphere was favorable for a large bowing squall line to develop over Illinois and progress eastward across the Ohio Valley. Western portions of Wilmington's warning area were placed under a moderate risk for severe weather by the Storm Prediction Center, and after 10 pm the entire warning area was placed under a tornado watch (see picture to the left). The line of storms moved into the area around 11 pm, and the strongest storms finally exited the area by 4 am.



Strong wind shear made the environment conducive for tornadoes to develop along the squall line. In fact, eleven tornadoes were confirmed within Wilmington's warning area alone. The first reports of damage that night were the result of one of the stronger tornadoes of the event. This tornado touched down in Celina, OH and caused substantial damage to residential and commercial districts. One of the more dramatic scenes was the partial collapse of a grocery store (see picture below). This tornado was rated an EF2 on the Enhanced Fujita Scale with winds up to 115 mph. Another EF2 tornado touched down in Licking County, OH near the town of Heath. The tornado passed very close to the Newark-Heath Airport, where an anemometer measured a gust of 102 mph before it was knocked out of service. Substantial structural damage also occurred with this tornado, including a masonry building that sustained a complete wall collapse. Four EF1 tornadoes touched down across central Ohio, as well as one in Switzerland County, Indiana. A few EF0 tornadoes were also confirmed in Ohio near St. Marys, Piketon, and Groveport.

While the extensive list of tornadoes sounds destructive enough, this event was not focused solely around rotating winds. The squall line produced straight-line thunderstorm winds of roughly the same magnitude as many of the weak tornadoes highlighted above. These winds knocked down numerous trees and power lines and caused minor structural damage. Two areas in particular suffered enhanced damage from straight-line winds, including the southern portion of the Cincinnati metro area near Richwood, KY, where part of the Interstate 75 rest area was damaged and three mobile homes were blown off their foundations. Winds in this area were estimated between 80 to 120 mph. The other area was near Fayetteville, OH, where a barn was blown across US 68 by estimated 100 mph winds.

Despite the extensive damage, there were fortunately no deaths or serious injuries reported with these storms. Overnight severe weather events pose a great threat since most people are asleep and not monitoring the weather. For this reason, the National Weather Service recommends having a NOAA All-Hazards Weather Radio so that you can be alerted for impending hazardous weather conditions anytime of the day or night!



An EF2 tornado with winds up to 115 mph caused this grocery store in Celina, OH to partially collapse on April 19th. Photo courtesy of Julie Dian-Reed (NWS employee).

## DSI: Damage Survey Investigation

Seth Binau

When strong winds associated with severe thunderstorms strike the area, there is often a great deal of interest in what caused the subsequent damage. Was it a tornado? A downburst? Straight-line winds? There are a number of different ways a thunderstorm can generate strong winds and a variety of terms meteorologists use to classify these strong winds. While Doppler radar and spotter reports are an essential part of the warning process, sometimes they aren't enough to officially say what caused the damage in a certain area. When those cases come up, a damage survey is usually conducted by staff members at the National Weather Service (NWS) to help answer the question, "What happened?"

In order to understand the damage survey process, one must first understand when damage surveys are usually warranted. Oftentimes after a severe weather event, the NWS receives numerous reports of damage that "must have been caused by a tornado." We sift through all of these damage reports equally and also consider spotter reports, radar data, environmental data, and eyewitness accounts of what happened to decide the likelihood that the damage was caused by tornadic or non-tornadic (e.g. downbursts, microbursts, straight-line) winds. What many people fail to realize is that non-tornadic thunderstorm winds can be very intense—sometimes in excess of 100 mph (the strength of a weak tornado). Although winds of this intensity are usually rare, when they occur they can cause damage on a much larger and more severe scale than could be otherwise imagined. Hence the common gut reaction, "It *had* to be a tornado!" If there is enough evidence from environmental and radar data, spotter reports, and emergency management feedback that a tornado may have occurred, a team of meteorologists is dispatched to the scene to investigate.

At the damage site, the meteorologists look for visual clues, talk to affected residents, view photographs of the storm (if available), and perform a detailed analysis of the debris field. Like a crime scene investigation, it is important to see the damage undisturbed, as it was left by the storm, so the meteorologists try to perform the survey before cleanup efforts commence. Some clues they look for that are tell-tale tornadic signatures include: mud spatter on both windward and leeward sides of structures, debris blown *inward* toward the path of the tornado (a tornado is a vortex that sucks debris inward towards its center at ground level), scour marks in fields, debris thrown upwind of its original location, and evidence that significant amounts of debris were *lifted* and tossed well downstream or away from the track. Remember, a tornado is a lifting mechanism, so tornadic debris will usually be lofted and not simply pushed over.



A meteorologist conducts a damage survey following a severe squall line that passed through Clinton County, OH in late October 2010. *Photo courtesy of Seth Binau (NWS employee).*

In determining the strength and classification of a confirmed tornado, the team will consider the entire debris field, including the condition of structures that were damaged. How well were the structures built? Were the roofs properly secured according to building codes? Were homes secured to the foundation slab correctly? These are all questions that must be answered. After considering a number of damage points in the debris field, a maximum wind speed is assigned to the tornado based on research

### The Enhanced Fujita Scale

Rating	Description	Wind Speed
EF0	Weak tornado	65-85 mph
EF1	Moderate tornado	86-110 mph
EF2	Significant tornado	111-135 mph
EF3	Severe tornado	136-165 mph
EF4	Devastating tornado	166-200 mph
EF5	Incredible tornado	> 200 mph

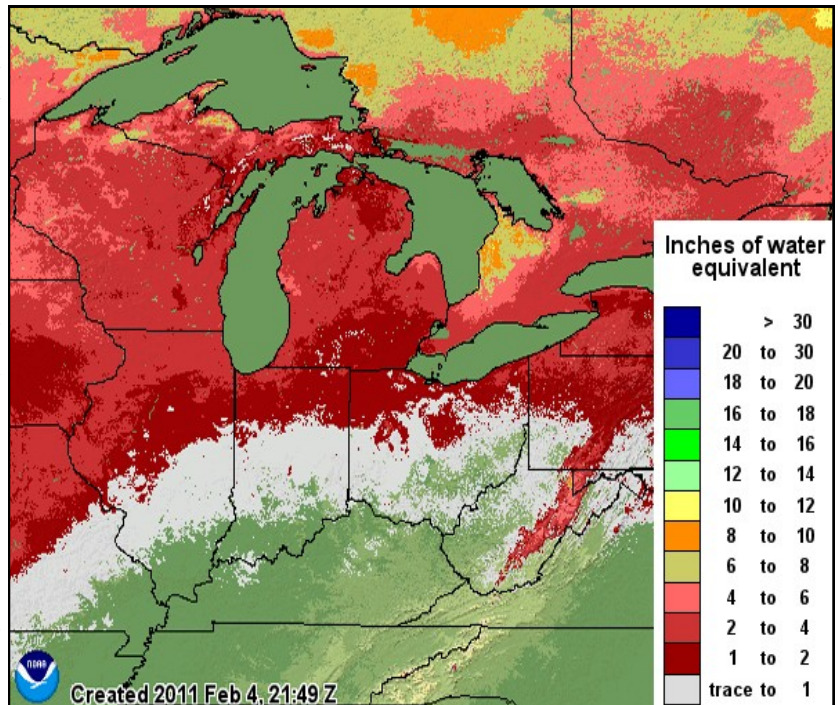
that has been accepted and verified in wind tunnel experiments at Texas Tech University. That wind speed is then fit to the Enhanced Fujita Scale, which was first drawn up in 1971 by the late Dr. Ted Fujita, a pioneer tornado researcher at the University of Chicago. This scale was modified slightly in 2007 but forms the basis for the tornado rating system we use today. After a rating is assigned, emergency managers, the media, and the public are notified about the specifics of the tornado via a Public Information Statement from the NWS. This statement includes information about the tornado's rating, path length and width, and time of occurrence, as well as a description of what led to the final rating.

## SWE??

Julie Dian-Reed

Is this a new text message lexicon? No, SWE stands for Snow Water Equivalent, a variable that can be one of the most misrepresented pieces of the puzzle when predicting winter floods. Why? Snow water **MUST** be measured in order for the National Weather Service and Ohio River Forecast Center in Wilmington to have an accurate understanding of how much water is in the snowpack *before* a flood. Can't the NWS just assume that every inch of snow contains a tenth of an inch of water? This would be a very error-prone assumption. The amount of water equivalent within snow can vary significantly, both when it is falling and after it has been on the ground for a while. To further complicate things, snowpack often contains a certain amount of ice as well.

An accurate assessment of SWE is critical for flood prediction. There is an agency within the NWS that provides *modeled* (not measured) snow water equivalent values for the United States. The National Operational Hydrologic Remote Sensing Center ([NOHRSC](#)) uses airborne gamma radiation technology on low-flying aircraft to take measurements of soil moisture and snow water equivalent. Although NOHRSC data is incorporated into river models, actual on-the-ground measurements are still critical, because clear skies are required to make these special flights. NWS Cooperative Weather Observers provide regular snow water equivalent measurements, but their spatial coverage is often sparse.



Modeled snow water equivalent after the Groundhog Day Blizzard of 2011. Map valid at 12 UTC on February 3rd. Image courtesy of NOAA/NOHRSC.

What does all this mean to you as a spotter? This is where becoming a volunteer CoCoRaHS observer can help. Once a week when snow is on the ground, CoCoRaHS observers take snow water equivalent readings. These CoCoRaHS reports are ingested directly by the Ohio River Forecast Center and NOHRSC to help complete the winter flood prediction puzzle.



Flooding of the St. Marys River headwaters area in St. Marys, OH on February 28th. Photo courtesy of Troy Anderson (Auglaize County EMA).

This past February 28th, the combination of two rare events occurred: severe thunderstorms in February and a rapid rainfall on top of snowpack. The result was flash flooding in Mercer, Auglaize, and Logan counties. Rapid water rises in these counties are not nearly as common as some of the more flood-prone areas across the region, but nearly four inches of snowpack from a previous storm played a key role in this flood. Estimated SWE values were likely lower than the actual values recorded in the St. Marys, Auglaize, and upper Great Miami river basins. This rapid flooding led to a state level disaster declaration.

Please consider joining the CoCoRaHS effort. To obtain more information, visit [www.cocorahs.org](http://www.cocorahs.org) or contact [Julie Dian-Reed](#) (regional coordinator) or [Ashley Novak](#) (Ohio coordinator).

## Join the CoCoRaHS Team!

Ashley Novak

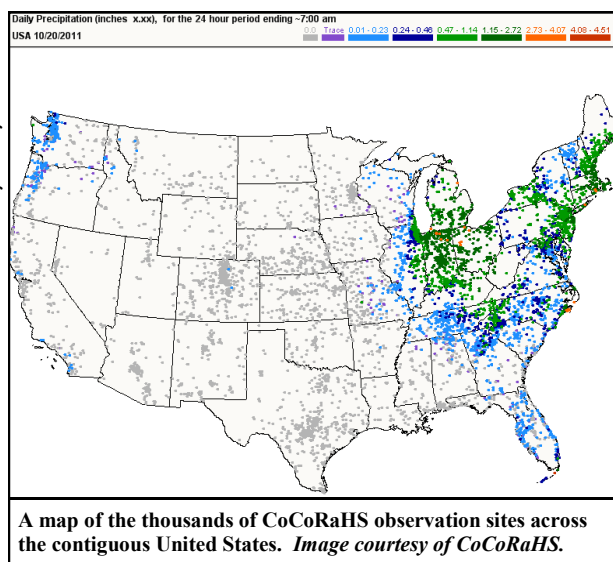


Do you have an interest in observing weather conditions where you live? Join the CoCoRaHS team! CoCoRaHS (the Community Collaborative Rain, Hail, and Snow Network) is a non-profit volunteer network of backyard weather observers of all ages and backgrounds. Each day, volunteer observers measure precipitation in their local communities and report it online for all to see. When significant weather occurs, CoCoRaHS observers can also submit real-time reports of intense precipitation or hail occurring at their location.

CoCoRaHS came about as a result of a devastating flash flood that hit Fort Collins, Colorado in July 1997. Precipitation in this event was highly variable and caused extensive damage. In order to be better prepared, CoCoRaHS was developed a year later with the intent of doing a better job at mapping and reporting precipitation. The network continued to spread across the United States until it became a nationwide network in 2010.

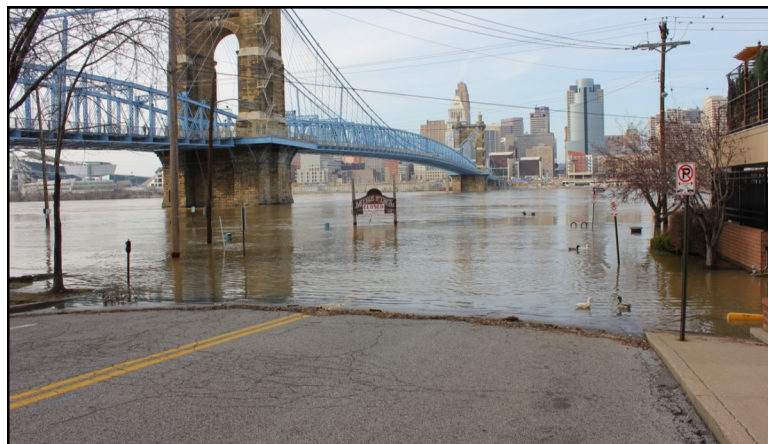
CoCoRaHS reports are extremely valuable to the National Weather Service and to many other agencies and individuals. Utilizing standardized low-cost measuring equipment and incorporating the importance of training and education, CoCoRaHS is a unique program capable of increasing reliable precipitation data by several hundred percent! CoCoRaHS reports help to accurately capture measurements of localized heavy rainfall that can result in dangerous flash flooding. These reports provide a tremendous amount of additional data that river forecast centers use to monitor and predict river flows and flooding conditions. Furthermore, CoCoRaHS provides a large database of accurate precipitation observations for analysis and study.

CoCoRaHS is fun and easy to join! Sign up by simply visiting the CoCoRaHS web page at [www.cocorahs.org](http://www.cocorahs.org) and clicking the "Join CoCoRaHS" link. Next, obtain a four-inch plastic rain gauge (information is available on the website). After that, view the online training slide shows or attend an in-person training session. Once you have viewed the training presentations, position your rain gauge in a good location in your yard. That is it! Now you can start observing precipitation, reporting your measurements online, and viewing other CoCoRaHS data. If you have any questions about the CoCoRaHS program, please contact [Ashley Novak](#).



## Record-Breaking Spring

(continued from page 3)



The Ohio River flooded in Covington, KY on March 13th. Photo courtesy of Andy Hatzos (NWS employee).

The record-setting spring rainfall and numerous severe weather events resulted in twenty-six counties within NWS Wilmington's warning area being declared part of a multi-state FEMA disaster declaration. The declaration was issued based on the staggering amount of damage caused by severe thunderstorms, tornadoes, and floods. The greatest monetary impact was by far due to flooding, with numerous mudslides and road collapses rendering roadways out of service for months in some locations. Ohio declared this the third costliest natural disaster in recent history (total losses estimated between \$322-400 million), behind the 1974 Xenia tornado outbreak (total losses estimated around \$1 billion\*) and the 2008 windstorm from the remnants of Hurricane Ike (\$1.135 billion in insured losses). Loss estimates were taken from the Ohio Insurance Institute's website.

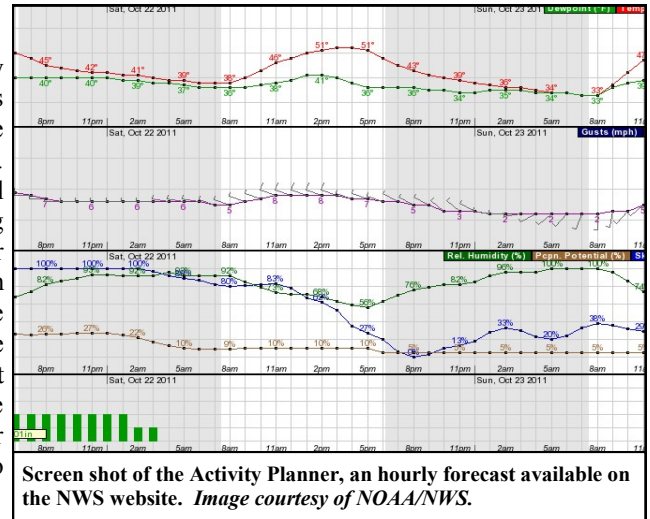
\* In 2008 dollars

## Enhancing the Short-Term Forecast

Andrew Snyder

Have you ever wondered if it will stay dry long enough for you to mow your lawn after work or if temperatures will drop low enough for frost to nip your fall flowers? For situations like these, the National Weather Service's goal has always been to provide accurate and up-to-date weather forecasts. Last spring, many NWS offices across the eastern U.S. (including Wilmington) embarked on a new forecasting methodology called the "Enhanced Short-Term Forecast" (ESTF). This venture incorporates more emphasis and detail in the near-term portion of the forecast period to provide the most accurate forecast possible for weather-dependent decision making.

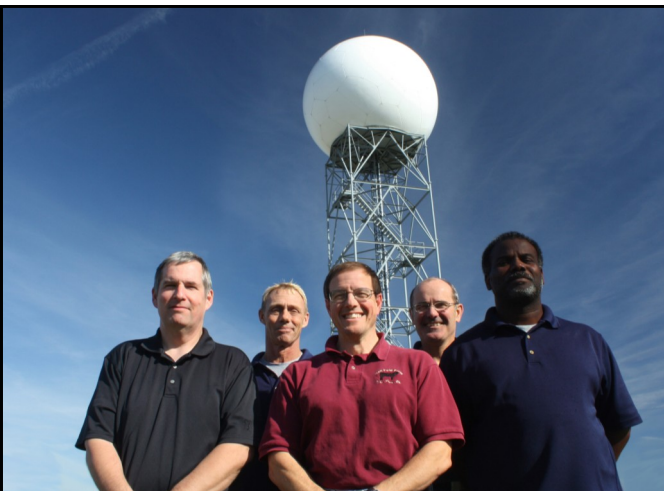
With the ESTF, the first 12 to 36 hours of the forecast are frequently reevaluated and updated at least once every three hours. How is this accomplished? The simplest way of updating the forecast is to take the latest observations and interpolate them into the current forecast. During quiet and "predictable" weather, the near-term forecast will usually be on track with little that needs changing. However, during developing weather, the near-term period may change rapidly. For these volatile situations, there are more and more high-resolution computer models available to help meteorologists predict the evolution of weather over the next several hours. These models are run every 1 to 6 hours to capture small-scale weather features, but due to the high computing load they only go out a short time into the future compared to the traditional forecast models. Like all computer models, they are not always perfect, but forecasters may be able to detect a trend for which it would be prudent to update the forecast.



Keep in mind that unless there are drastic changes, most of these forecast updates will have no noticeable impact on our text products or those played on NOAA All-Hazards Weather Radio. To see the finer hourly forecast details of the ESTF, there are two displays available to choose from on our website, [www.weather.gov/lin](http://www.weather.gov/lin). These include the "Activity Planner" and "Graphical Forecast" links found underneath the regional map on the homepage. Colored maps of the region showing the latest NWS gridded forecast data can be seen by selecting "Graphical Forecast Images" next to the aforementioned links.

## Teamwork

(continued from page 1)



The "Fantastic Five" electronics technicians of the Wilmington, Ohio National Weather Service office. From left to right: Alan, Mark, Matt, Frank, and Curtis. Photo courtesy of Michael Kurz (NWS employee).

Shortly thereafter, the office received a report that law enforcement had spotted a tornado just east of Georgetown, Ohio. As other storms developed across southwest and south-central Ohio (these also showed rotation on neighboring radars), NWS Wilmington issued several subsequent tornado warnings and continued to receive numerous spotter and public reports of funnel clouds and possible tornadoes. One of these phone calls even alerted NWS meteorologists to a large funnel cloud that formed just a few miles south of the office and briefly touched down in a nearby field!

After working diligently for some time, the two ETs were able to fix the radar and even stayed awhile to ensure it was running smoothly for meteorologists to use as the severe event was winding down. NWS Wilmington's elite group of five electronics technicians is always more than willing to do whatever they need to do or go wherever they need to go to fix a facilities or equipment-related problem, regardless of the time of day or night, whether it is a weekday/weekend/holiday, or whatever weather conditions they might face. They are often the unsung heroes in the National Weather Service, and they deserve special recognition for the great work they do. Special thanks to our dedicated and professional group of electronics technicians!

## The Sizzling Summer of 2011

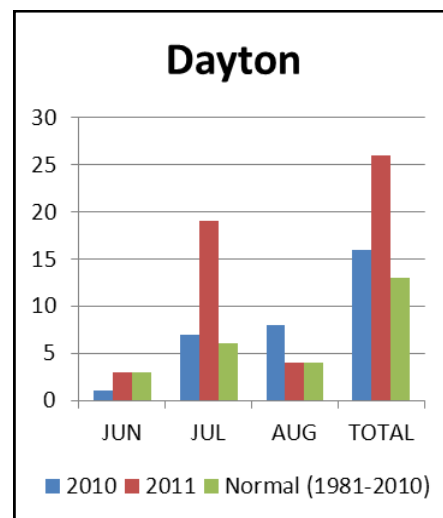
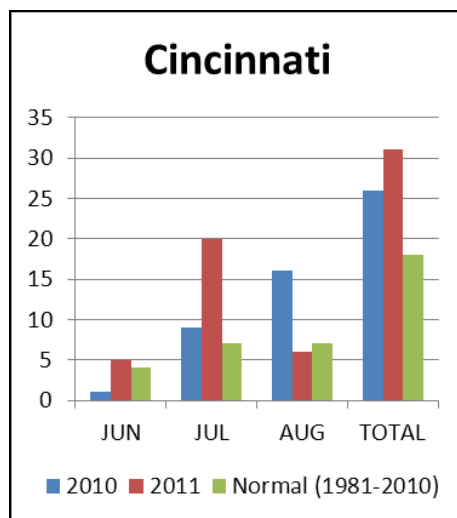
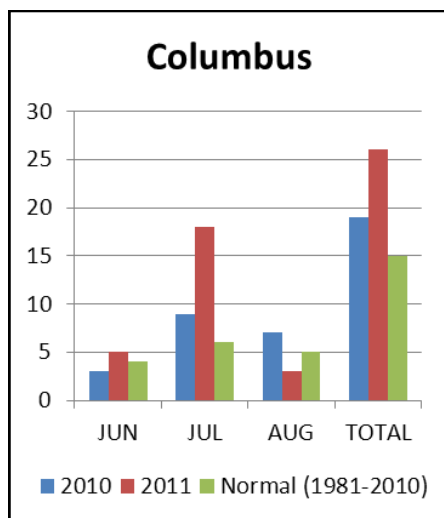
Michael Kurz

Without a doubt, the summer of 2011 was a warm one. The average daytime high across the area from June through August was in the mid 80s, and the average nighttime low was in the mid 60s. This resulted in the summer of 2011 finishing about two to three degrees warmer than normal ("normal" refers to the 30-year climatological average period, currently from 1981-2010) across the Tri-State area. While there were several warm and humid spells throughout this summer, it was primarily a persistent heat wave during the latter half of July that was responsible for making this past summer warmer than normal. Many will remember that the summer of 2010 was also very warm. In fact, in terms of temperature, this past summer was (as a whole) quite reminiscent of the summer of 2010. Below is a table that shows the 2010 and 2011 average monthly temperatures and their departure from normal (in parentheses) for Columbus, Cincinnati, and Dayton. The table also includes the average summer temperature for both years.

	JUNE		JULY		AUGUST		SUMMER AVERAGE	
	2010	2011	2010	2011	2010	2011	2010	2011
<b>CMH</b>	74.3 (+3.1)	72.5 (+1.3)	77.0 (+1.9)	80.2 (+5.1)	76.3 (+2.8)	74.5 (+0.6)	75.9	75.7
<b>CVG</b>	75.0 (+3.0)	72.8 (+0.8)	77.9 (+1.6)	80.9 (+4.6)	78.1 (+3.6)	75.9 (+1.1)	77.0	76.5
<b>DAY</b>	73.3 (+3.1)	71.6 (+1.4)	76.4 (+2.1)	79.8 (+5.5)	75.8 (+3.5)	73.9 (+1.2)	75.2	75.1

One can clearly see how hot July 2011 was in comparison to every other month, but it is also interesting to note that each month was warmer than normal at all three locations, both in 2011 and 2010. Despite the variability in temperature from month to month (June and August were warmer in 2010 than they were in 2011, while July was significantly hotter in 2011 than 2010), the overall average summer temperatures were quite similar.

Despite finishing just a tad cooler than the summer of 2010, this past summer outranked that of 2010 in terms of the number of 90+ degree days. Below are graphs for Columbus, Cincinnati, and Dayton comparing the number of 90+ degrees during the summers of 2010 and 2011 to the average number of 90+ degree days during the 30-year climate normal period.



While June and August of this year were generally close to normal in terms of the number of 90+ degree days, July 2011 was quite remarkable. In fact, with eighteen days, Columbus tied for fourth place for the most 90+ degree days it has recorded in any month (the most since twenty days in July 1999). Cincinnati tied for eighth place with twenty days (the most since twenty-five days in August 2007), and Dayton tied for sixth place with nineteen days (the most since nineteen days in July 1944). Also worth noting is that on August 2nd, Cincinnati tied its record longest streak of seventeen consecutive days with high temperatures of 90+ degrees (this last occurred in July 1901).

# A Review of Late-May Severe Weather Events

Andy Hatzos

Climatologically speaking, late May is one of the most favored times of the year for severe weather in Ohio, Kentucky, and Indiana. This year was no exception to the rule, with a four-day stretch providing one of the busiest severe weather periods of 2011 across NWS Wilmington's warning area.



Shelf cloud on the leading edge of a strong thunderstorm passing over the Dayton International Airport on May 23rd. Photo courtesy of Ben Cooper.

On Monday, May 23rd, an intense line of thunderstorms developed over Indiana and quickly moved east across southern Ohio and northern Kentucky. This line of storms produced numerous wind gusts in excess of 60 mph, resulting in widespread damage. With a significant amount of wind shear in the atmosphere, conditions were also favorable for the development of tornadoes within the squall line. National Weather Service damage surveys confirmed four tornadoes from this event: two were rated EF0 on the Enhanced Fujita Scale (near Sunman, IN and Edenton, OH) and two were rated EF1 (near Fairborn and Springfield, OH). Despite the tornadoes, the most significant damage occurred from straight-line winds in Union County, IN and Preble County, OH. Structural damage in those locations was estimated to have been caused by winds of up to 100 mph.

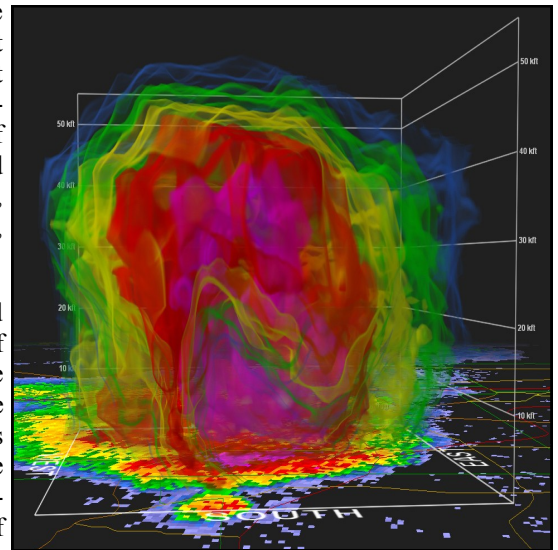
Two rounds of severe weather occurred on Wednesday, May 25th. The first round featured a long-track supercell moving from Indiana into Ohio during the early evening. This well-organized storm had a

lifespan of over five hours and produced some of its worst conditions in the southern and eastern Dayton suburbs. The storm's strong rotation and updraft made it capable of generating extremely large hail, and some of the largest hail was reported around the Miamisburg, Centerville, Bellbrook, Beavercreek, and Xenia areas. Through this corridor, the storm produced a swath of hail larger than two inches in diameter, and in some areas the hail measured up to three inches in diameter! Although the storm exhibited strong rotation, conditions in the lower atmosphere were not supportive of strong tornadoes, and only a brief EF0 tornado was confirmed near Centerville, OH.

Shortly after midnight on Thursday, May 26th, another line of storms pushed into the area. Overall, this line of storms was not as strong as the one on May 23rd, though there were a few reports of wind gusts around 60 mph. Conditions were again favorable for brief tornadoes to form on the front edge of the line of storms, and three were confirmed by damage surveys. Two EF0 tornadoes developed near Bloomingburg, OH, and an EF1 tornado damaged several homes in Liberty Township (Butler County, OH). The stretch of severe weather finally came to an end later that evening after a final round of strong storms. These storms produced isolated wind damage and hail across portions of northern Kentucky and southern Ohio.



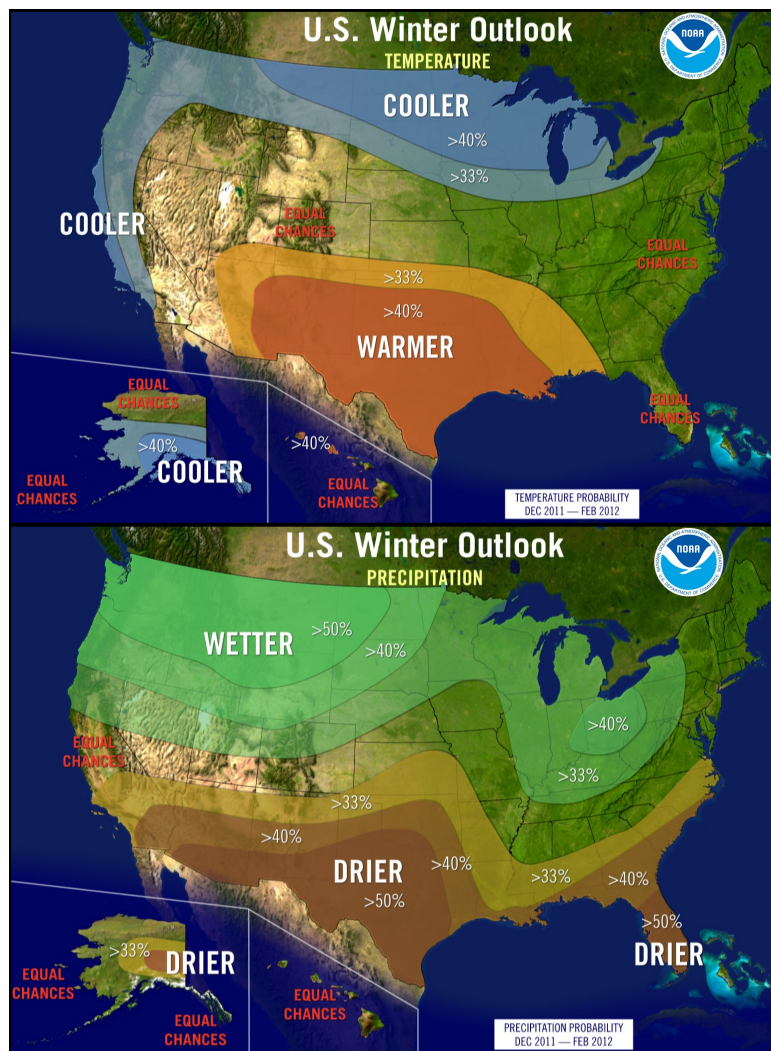
An EF1 tornado with winds up to 105 mph flipped this vehicle over in Liberty Township. Photo courtesy of Julie Dian-Reed (NWS employee).



Three-dimensional radar image of the supercell that produced extremely large hail on May 25th. The pink core of the storm represents the very high reflectivity of the large hailstones. Image courtesy of NOAA/NWS, viewed via Gibson Ridge Software's GR2Analyst.

During this sequence of severe thunderstorms, the National Weather Service in Wilmington issued a total of seventeen tornado warnings, sixty-four severe thunderstorm warnings, and one flash flood warning. As mentioned in the "Record-Breaking Spring" article, this active period of weather resulted in an estimated \$322-400 million in statewide losses across Ohio, making it Ohio's third costliest natural disaster in recent history!

## The 2011-2012 Winter Outlook



NOAA's Climate Prediction Center recently released their outlook for the upcoming winter. As seen in the maps above, the Ohio Valley will see equal chances for above-, below-, or near-normal temperatures and a 40% chance for above-normal precipitation. This wet outlook is characteristic of a La Niña pattern. La Niña refers to below-normal ocean temperatures in the eastern equatorial Pacific Ocean, which in turn affect thunderstorm patterns in the tropics and eventually the overall global wind circulations. There was a strong La Niña pattern last winter, and those below-normal ocean temperatures are becoming established once again for this winter. Typically during La Niña winters, an upper level trough becomes dominant over the eastern United States, leading to frequent winter storms over the Ohio Valley.

Note that shorter-term climate variables, such as the Arctic Oscillation (which can send surges of cold air into the United States), are not accounted for here, since these patterns are only predictable up to a couple weeks in advance. Thus, while the maps above give an *overall* winter forecast, there may be stretches of wet/dry or warm/cold weather during the winter. Also, this forecast does not predict snowfall amounts, which are highly dependent upon individual winter storms.

Some picturesque weather occurred at NWS Wilmington over the past year. On top, a double rainbow which occurred on April 28, 2011 (photo courtesy of Michael Kurz, NWS employee). On bottom, a departing cumulonimbus cloud on June 16, 2011 (photo courtesy of Andrew Snyder, NWS employee).



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A frost advisory has been issued for the entire forecast area through early Saturday morning.

Temperatures across the region tonight will drop well into the 30s, leading to the first widespread frost of the season. While most locations will experience temperatures in the mid to upper 30s, outlying areas may drop into the lower to mid 30s. With frost expected to form, sensitive outdoor plants may be killed if not covered or brought inside.

Stay warm, everyone!

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